ATTACHMENT 42

EXHIBIT 46

VPLS in an Integrated Wired and Wireless Environment

February 2006

Susan Hares, NextHop technologies

Agenda

- Global Wired-Wireless LANs
- Traffic Data and Control
  - Two Examples of Global LANs
  - Keys to Scalable, Secure Global LANs
- VPLS connected Wired/Wireless LANs
  - Scaling Wired/Wireless switch/routers
  - Single Provider, Multi-provider
  - Scaling WLAN
- Security
- Combined Network management

Global Wired/Wireless LANs

- Wired and Wireless Corporate LANs built from:
  - Router, Ethernet Switch, WLAN Device, AP or
  - New Generation of Integrated Wired/Wireless router/switch + APs

- Corporate LAN networks connect to Virtual Ethernet Pipes across the world
  - Virtual Private LAN Service connects LANs

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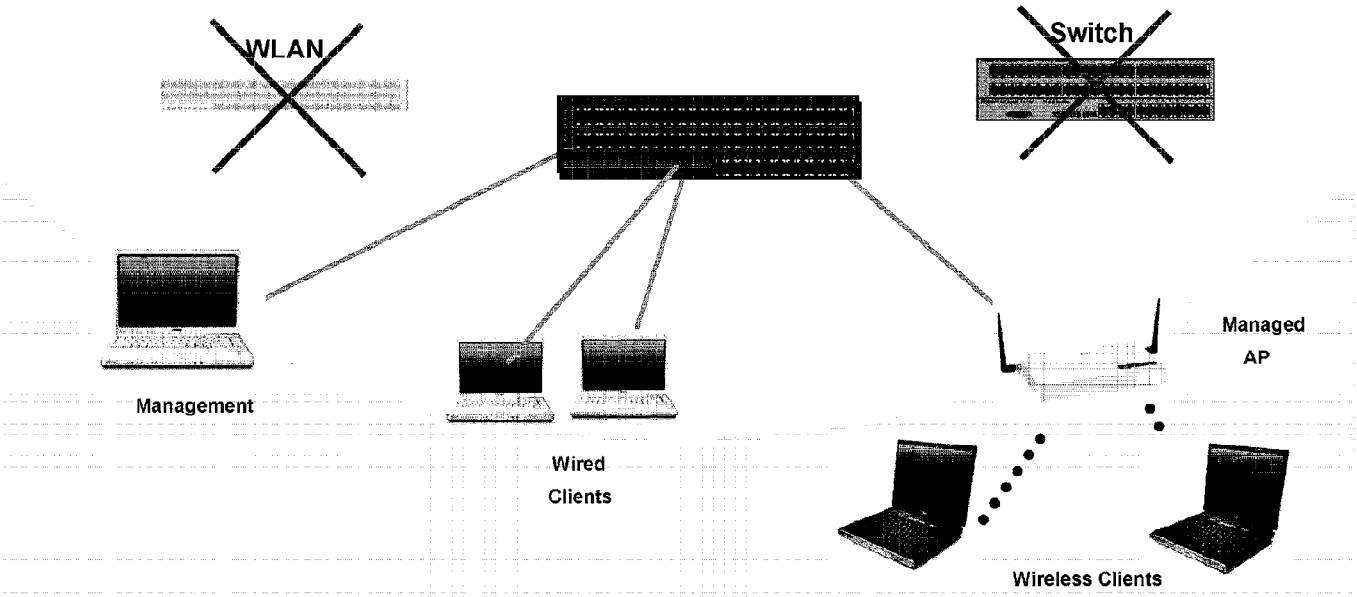
Wired and Wireless Switches

- Wired and Wireless Switches
  - Ethernet with Switched Fabric
  - Wireless LAN with Power over Ethernet & Centrally Managed AP



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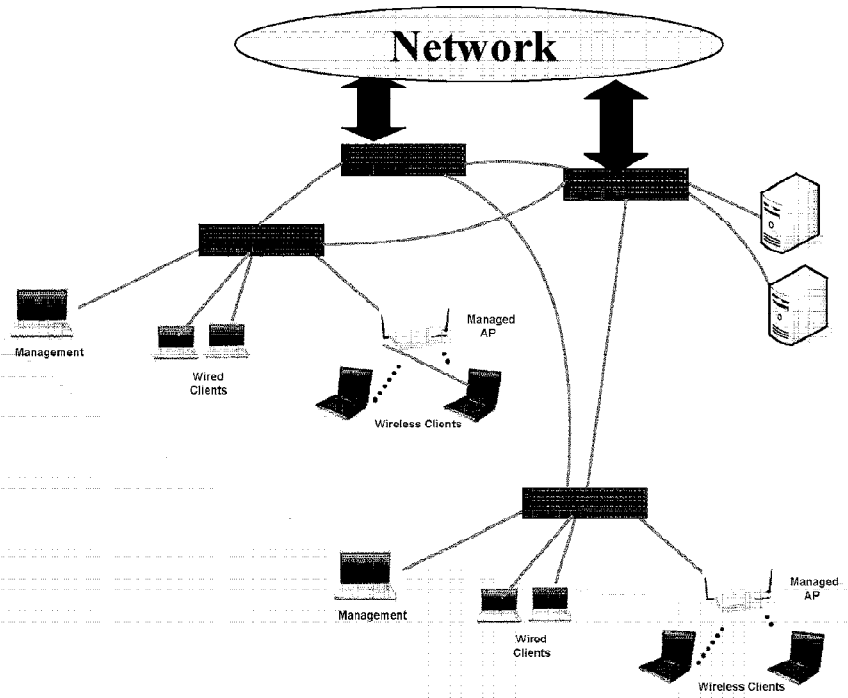
Large Corporate Networks



- Yesterday's Corporate network connected sites via
  - Frame Relay or Dedicated lines
- Today's networks glue the large corporate networks
  - MPLS
  - Using VPLS (Layer 2) or
  - L3 VPNS

VPLS = Virtual Ethernet

- Virtual Ethernet
  - WAN distance
  - Ethernet Broadcasts, multicast
  - ARP, Ping, DNS queries stress Virtual Ethernet

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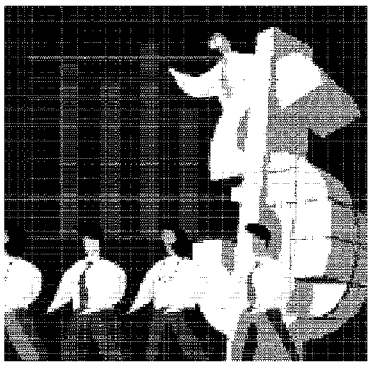
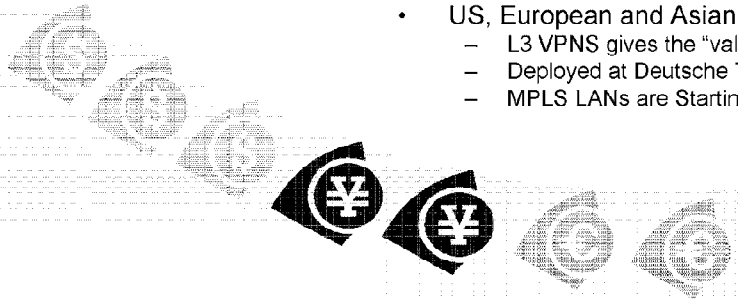
Markets for Global Wired/Wireless LANs

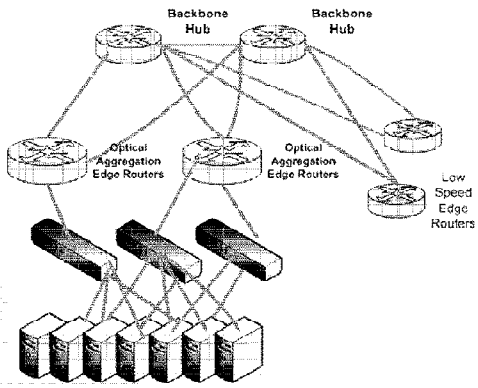


- Carriers see L2 VPNs as a "profitable"
  - L2 VPN provide a "value-add" service that can have premium rates relative to IP commodity transport
  - US Networks must get beyond commodity traffic to become profit with the Internet
- US L2 VPNs are gaining ground
  - US Carriers such as Bell South & AT&T may change IP transport to Layer 2 VPNs
  - XO announced a change to Wireless Metro Ethernet Market
  - Exchange Points (Equinix, Abovenet) provide Layer 1/Layer 2 inter-connect to Content Providers and Networks
- Large Asian Metros connect via Metro-LANs
  - Metro Ethernet in Asia connect Large Cities and run down railways
  - Japan Targets are: 30 Million Subscribers at 10MBps, 10 Million at 100MBps
  - Korea, China, etc are following suit
- US, European and Asian Carriers using L3 VPNS
  - L3 VPNS gives the "value-add" service with premium Rates
  - Deployed at Deutsche Telekom, Saavis (IP-sec to L3 VPns), AT&T
  - MPLS LANs are Starting to penetrate large Enterprises



Two Enterprise Deployments: Data Center and Call Center

AOL Hub Design



AOL Data Center – What's in

- Information Topologies:
- Live streaming Video traffic
- Massive Storage
- DNS Load balancing

Heart of it all: L2 Switches with high throughput

- VOIP Call Centers reduce costs
  - Small Business use reduce cost "VOIP providers" such Vonage or Skype
  - VOIP from traditional carriers

  [*NANOG 33(2003): What makes SIP difficult in the Internet (jiri.pdf),*

  NANOG (2005): Securing Carrier VOIP]

- Special VOIP services
  - Hot-line for networks Problems
  - Emergency service for Disasters

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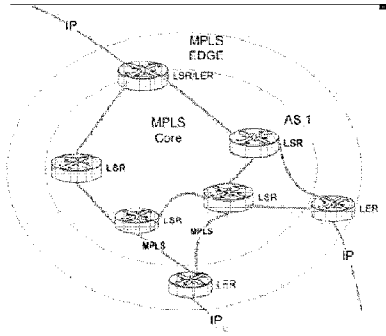
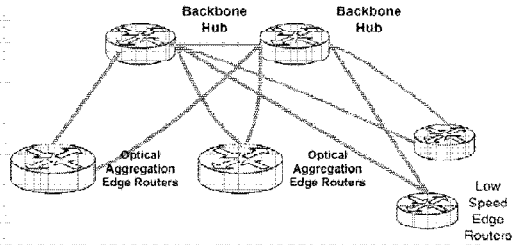
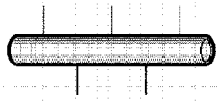
MPLS/TE Networks Supporting AOL



AOL Hub Design





- Deutsche Telekom – TE MPLS
  - Ring around the network with firewalls
  - MPLS traffic Engineering via IGP
    - Cariden tuning
    - Junos & IOS MPLS issues
  - NANOG 33 presentation (IGP tuning in MPLS network – Martin Horneffer, T-COM)
- AOL ATDN network - TE IP
  - Tuned IGP with massive switching Back-end
  - 25K servers, 66K interfaces, 800 optical routers
  - 250 Gigs/sec of Edge traffic
  - 36 Pops on 4 Continents (200 AS, 125 ISPs)
  - IGP lean, carry everything in BGP
  - **NANOG 34: Design Decisions and Architecture Analysis of a Global 10G Backbone (We Do it, so You Don't Have To)** Vijay Gill
- Exchange Carriers: Equinix
  - has 6 out of 7 Exchange points to link WANS
  - L1 with value Add at L2 and L3
  - Large Switches

Keys to Global L2/L3 LANs

- Scaling the processes for forwarding
  - L2 Ethernet: Data Plane
  - L2 Group MAC (802.11/802.3)

Unicast forwarding

Multicast forwarding

- Scaling control plane traffic
  - Provisioning Process
  - Failure Re-provisioning process

MPLS PWs provisioning

- Scaling the Provisioning OAM
  - Automatic L2 VPN/L3 creation
  - Failure Detection & Automatic re-establishment of VPNs

OAM to detect brown-outs

- Securing the Network
  - WLAN Rogue detection
  - Firewall and IDS/IPS

Data Encryption

WLAN Rogue Detection

Firewalls/IDS/IPS

Scaling the Data Forwarding

- WLAN/LAN Triple-Play Traffic
  - Network requirements
  - Enterprise usage of Voice, Video and Data
  - Multicast in Global LANs
- Scaling the Device for WLAN/LAN Global VPLS
  - VOIP Convergence
  - Single and Multi-Provider convergence
  - Scaling the WLAN

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WLAN/LAN Data

Requirements of Network for Data	VoIP	Video	Data		
			Transaction (SQL/SAP)	Web	Email
Data latency	< 50 ms	medium	medium	Cache & accelerators allow web to tolerate high	Tolerates High
Data Jitter	Low	Low	medium	Tolerates High	Tolerates High
Data path failover	< 50 ms		Medium	Tolerates High	Tolerates High
Efficient Multicast	Small	Critical for High Numbers	Small	Small	Small
Unicast	Most Data	Small	Medium	Huge	Huge, Spam
Secure	High	Mixed	Medium	HTTPS & HTTP	Mixed
Wire-Tap	Must	Should	Should	Should	Must

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WLAN/LAN Market in Enterprises

- Large - 1K APs, 10K switches, 25K servers, 40K stations
- Medium – 100s APs, 1K switches, 500 servers, 2K stations
- Small - 10s APs, 3 switches, 2 servers, 100 stations

	WLAN Scale	VLAN Scale	VoIP	Video	Data
Large Enterprise Market	1000s of APs 10,000s stations 10s of switches Multi-site	25K servers, 10K-40K WS 2K switches .8K Routers	<50ms handover Seamless roaming SIP proxy / CAC 802.11e / WMM Wifi to cell UMS Spectralink support 802.11r	Smooth Failover of L2 / L3 Seamless Roaming Video Finder/proxy 802.11e/WMM 802.1 Broadcast 100s Multicast Groups	Bulk & Spam Email Transactions: SQL, SAP, HTTP 15-20K Web Servers 15-20K Email Servers
Mid-size Enterprise Market	100s of APs 500-1000 stations <24 switches One or two sites	500 servers 2K WS 24-50 switches 10-100 routers	<50ms handover Seamless roaming 802.11e / WMM Spectralink support 802.11r	Smooth Failover of L2 / L3 Seamless Roaming Video Finder/proxy 802.11e/WMM 802.1 Broadcast 100s Multicast Groups	Bulk & Spam Email Transactions: SQL, SAP, HTTP 300-400 Web Servers 300-400 Email Servers
SMB/SME Market	<10 APs <100 stations <3 switches	< 2 server < 100 WS < 3 switches	Consumer handsets	Security Camera or Egg Camera Video 2-3 Multicast Groups	1-2 joint Email/ Web Server

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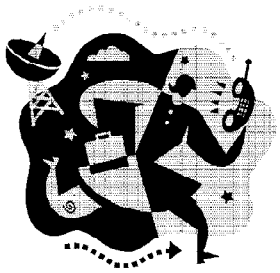
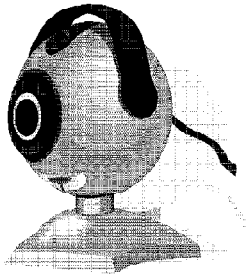
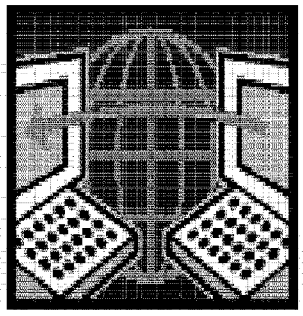
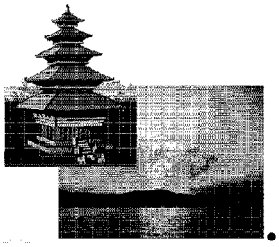
Multicast in Global LANs









- Multicast is driven by Triple Play
- Where do we see Triple Play?
  - Long skinny countries with a railroad down the center
    - Thailand
    - Japan
    - Nordic Countries
  - IP TV Multicast replaces server
  - Banking use multicast to get around legal issues of stock distribution
  - Distribution of software or news
  - Next Generation Games
  - VoIP Conference calls
- Traditional Multicast over MPLS forwarding
  - Does not scale well
  - Multicast MPLS uses Multicast techniques at MPLS

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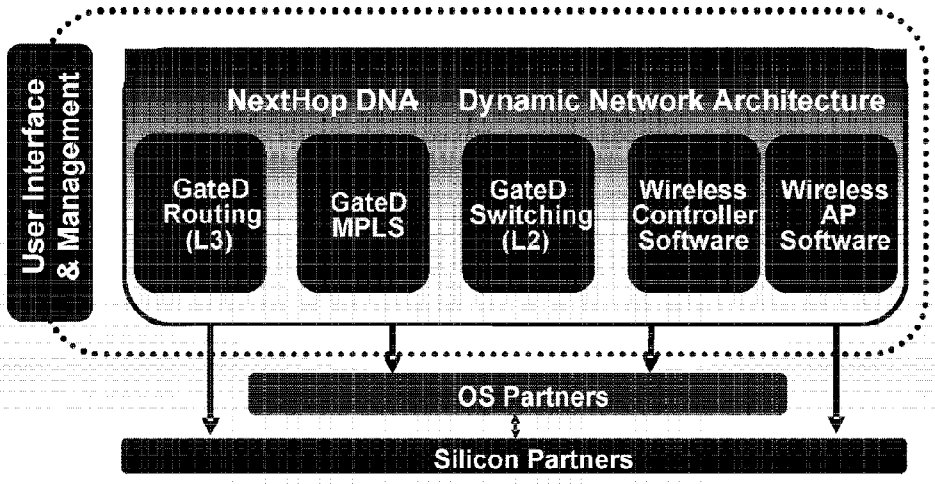
WLAN/LAN VPLS Device

- Scaling L2/L3 Global WLAN/LAN VPLS device
  - Quick VOIP convergence, Scalable Multicast
- Scaling Single Provider VPLS
- Scaling Multi-Provider VPLS



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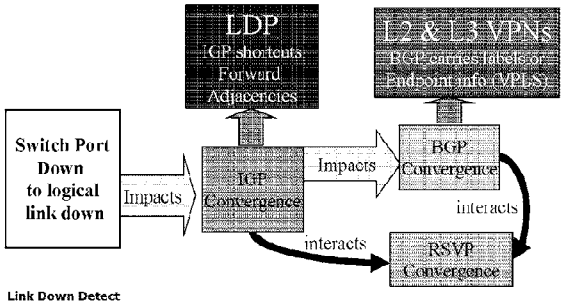
VOIP Convergence



Link Down Detect
D = Minimum(3 *Link-timer, S-out)

IGP convergence:
LoC(p) = D + O + QSP + (h * F) + SPF(n) + RIB (p)
FIB(p) + HW + GRR

LDP convergence:

LDPoc(p) = D + LoC(p) + LO + (h * (LDP-node))*Path + LIB + LFIB

LDP-node = Lr + LSP-RS-Policy + LD + LSP-DS-Policy + Lx + LIB + LFIB *(preliminary)*

BGP Convergence

E-BGPec(p) – Ur + [illegible] + IBGPec+ FBGP-ipec + FBGP-ASpec + FIB + GRR

RSVP:
LoC(p) = RR + RRO + QSP + (h * [illegible]) + LIB + LFIB

- RR: Reservation Requested
- RRO: New RSVP Request (Insertion of External routes occurs here)

- L2 Process convergence requires:
  - Quickly handle port on/off
  - Quick MAC learning
  - VLAN assignment
  - Port Trunking
  - STP/RSTP/MSTP spannig tree
- Layer 3 scaling
  - IGP: Scale the SPF and speed up the interface down time
  - BGP: Speed up the policy
- The MPLS quick convergence:
  - RSVP-TE and LDP process and provide pre-calculated back-up paths that make before breaking,
- VPLS processing running on top of all of these must do all of these plus focus on the MAC transfer

L3 and MPLS convergence

Keys to Scaling Single Provider

Single Provider					
Requirements	IP	MPLS	Layer 2		
			802.3	802.11	WLAN/ LAN
Data latency	Hardware based TOS or Diff-Serv Queues	Hardware based TOS or Diff-Serv queues link to Tags	802.1p marking & queues	802.11e marking & queues	Switching between 802.1P to/from 802.11e
Data path failover	Based on IGP + Hardware Update time	Based on IGP & LDP or RSVP-TE + Hardware Label update time	802.1 Spanning Tree impacted by 802.11 beacons & change rate of combined wireless/wired topology + Hardware MAC update time		
Efficient Multicast	IGP + PIM + Hardware Forwarding	Multicast MPLS or IGP + PIM overlays plus the Layer 2 timeout + Hardware Forwarding	Spanning Tree broadcasts are bad for 802.3, and worse for 802.11 with minimum forwarding (Rbridge (IETF) and 802.1 improvements for Link-state protocol to share MAC addresses) + Hardware forwarding at 802.3 and 802.11		

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Rbridge in VPLS envirnonment

- Rbidge Creates Core of Layer 2 Bridges that are fully meshed
  - Multicast can be tuned to only transmit on the Rbridge that is needed
  - Layer 2 improvements can allow MPLS multicast to be efficient

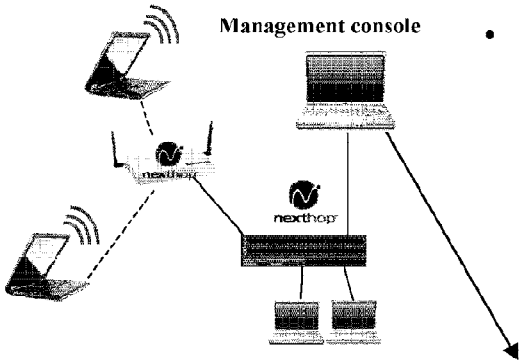
Multi-Provider VPLS with WLAN/LAN

Multiple Providers					
Requirements	IP	MPLS - VPLS	Layer 2		
			802.3	802.11	WLAN/ LAN
Data latency	Hardware based Tos/Diff-Serv Queues	Hardware based Tos/Diff-Serv Queues for Tag	802.1p marking & queues	802.11e marking & Queues	Switching between 802.1P to/from 802.11e
Data path failover	Based on IGP + BGP + Hardware Update time	Based on IGP & LDP or RSVP-TE + Cross-Network Signaling + Hardware Label update time	802.1 Spanning: - impacted by 802.11 Beacons , change rate of 802.11 network, VPLS (IGP,BGP) and MAC learning		
Efficient Multicast	IGP + PIM + Hardware Forwarding	Multicast MPLS or IGP + PIM overlays plus the Layer 2 timeout + Hardware Forwarding	Broadcast Replicates the Layer 2 traffic everywhere - ARP, DNS use Broadcast True Multicast requires IP + VPLS + 802.1/Rbridge convergence **L3 OSPF uses L2 Multicast**		

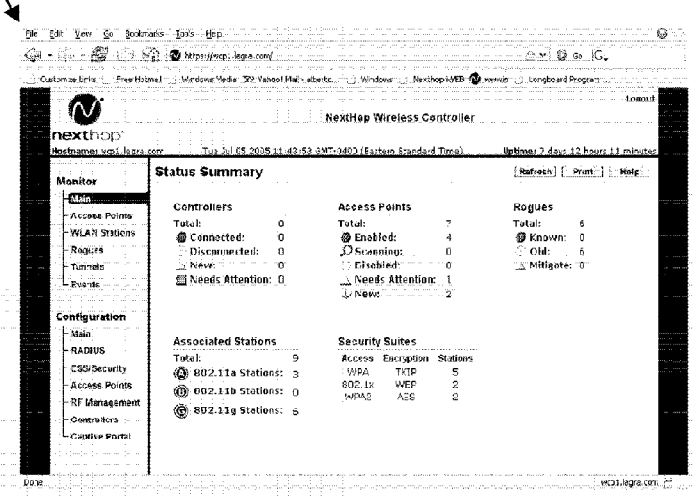
Scaling Global WLAN

- Scaling the Switch/Router
- Simple Centralized WLAN AP and Switch
- WLAN RF planning
- LAN / WLAN integration

Simple, Centralized Management



- Advanced management features
  - One place to manage switch and all APs
  - Integrated WebUI
  - Industry Standard CLI
  - SNMP management
  - Best-of-Breed RF management through DNA partners



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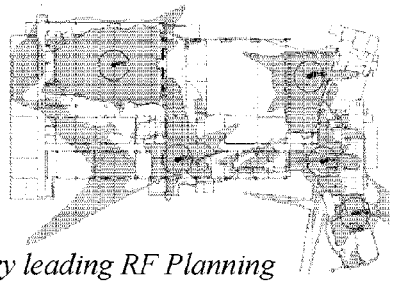
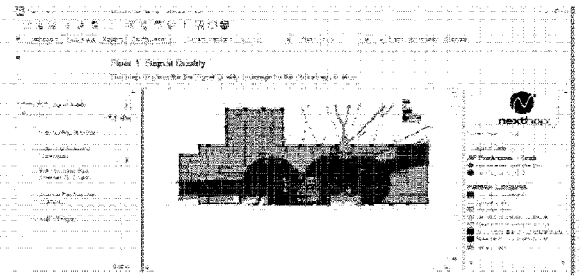
RF Management



Industry leading RF Planning

- Wireless Valley DNA partnership
  - RF Planning
    - Multi-floor buildings
  - RF Mapping
    - RF environment troubleshooting
- Core NextHop capabilities
  - Dynamic Transmit power control
    - coverage hole detection/mitigation
  - Automatic channel selection



802.11k visualization – signal quality vs. application

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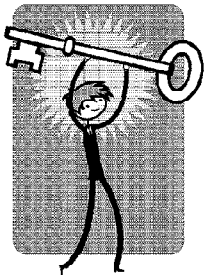
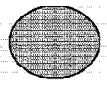
Security Issues

- Wired/Wireless Security
  - Authentication & Secure Access Circuits
  - Assign Encryption & VPN ids
  - Protect against Attacks
    - Bot Armies march on broadcast ARPs, Multicast queries
    - Will kill the scaling
- Attacks versus Brown-outs
  - Like NE Power-outage of Aug 2003: Attack or old-network
  - Network Brown-out statistics need to be kept
  - L3: netflow, ping, ETE)
  - MPLS: ***mflow***, mpls-ping, ETE
  - L2 Ethernet: sflow, 802.3++ ETE
  - L2 Wireless, ***rf-info***, 802.11K, ETE
- Attacks on MPLS over Ethernet
  - L2 VPLS/VPWS, L3 VR (IP-Sec), L3 MPLS
  - Combination of Tunnels
  - Use of Radius to configure the VPN ID based on security key (draft-ietf-l2vpn-radius-pe-discovery-01.txt)





WLAN/LAN Market Requirements

	WLAN Scale	VLAN Scale	NMS / Management	VoIP Security	WLAN/ LAN Security
Large Enterprise	1000s of APs 10,000s stations 10s of switches Multi-site	25K servers, 10K-40K WS 2K switches .8K Routers	Mgmt platform CLI SNMP XML Detailed reporting Integration w/3rd party mgmt	Encryption of Data Wire Tapping Seamless roaming with wire-tapping	802.1x / WPA2 IPS / IDS Client integrity Multifactor auth Rogue handling *VPLS security*
Mid-mkt	100s of APs 500-1000 stations <24 switches One or two sites	500 servers 2K WS 24-50 switches 10-100 routers	SNMP Multi-box web UI Simple reports and alerts	Encryption of Data Wire Tapping Seamless roaming with wire-tapping	802.1x / WPA2 Client integrity Rogue handling *VPLS Security*
SMB/SME mkt	<10 APs <100 stations <3 switches	< 2 server < 100 WS < 3 switches	Web UI Simple alerting Easy deployment	Consumer handsets Wire tapping	802.1x / WPA2 Rogue handling Local authentication *VPLS Security*

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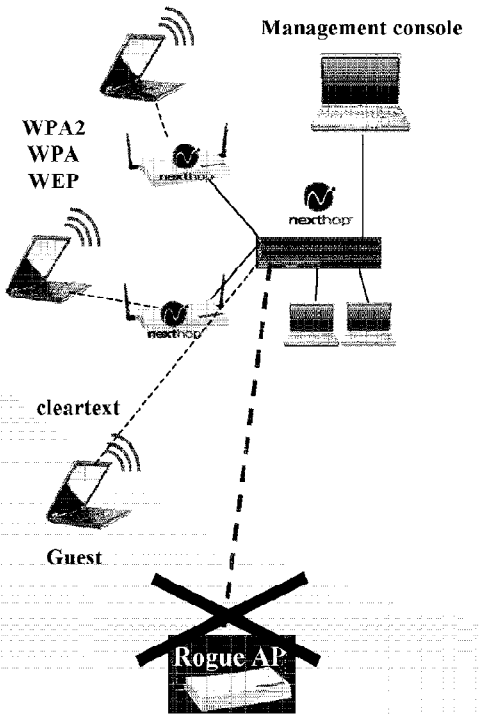
Enterprise Class Security



- Encryption: WPA2, WPA, WEP
  - Separate VLAN per security type
  - Captive portal for guest usage
- Strong, scalable authentication with 802.1x and protected EAP
  - Supports external RADIUS authentication
  - Local EAP termination (for small/medium business)
- Rogue AP detection and mitigation